EBERHARDT SCHOOL OF BUSINESS

Business Forecasting Center

Benefit – Cost Analysis of Delta Water Conveyance Tunnels

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Summary

This report is the first comprehensive economic benefit-cost analysis of the water conveyance tunnels at the center of the Bay Delta Conservation Plan (BDCP). We find the tunnel is not economically justified, because the costs of the tunnel are 2.5 times larger than its benefits.

Benefit-cost analysis is an essential and normal part of assessment and planning of large infrastructure projects such as the $13 billion water conveyance tunnel proposal, but has not been part of the BDCP. This report fills an important information gap for policy makers and water ratepayers who will ultimately bear the multi-billion dollar costs of the project. The results can be easily updated if changing plans generate updated estimates of benefits and costs, but the gap between benefits and costs is so large that it seems unlikely that the tunnels could be economically justified in any future scenario.

The principal author of this report is Dr. Jeffrey Michael, Director of the Business Forecasting Center (BFC) at the University of the Pacific. The BFC is among the most recognized economic research centers in California, and is known for its expertise on the Central Valley economy, growth resource issues facing the region. On water issues, the BFC is known for being the only academic or government entity to accurately assess employment impacts during the 2009 drought, and recently led the development of the Economic Sustainability Plan for the Delta Protection Commission. This report is part of the Center's independent research and analysis of economic issues and trends in the state and region.

Benefit – Cost Analysis of a Delta Water Conveyance Tunnel

A $13 billion water conveyance tunnel is being considered as the centerpiece of the Bay Delta Conservation Plan (BDCP). The tunnel would divert water from the Sacramento River and convey it around the Delta to state and federal water projects serving southern California rather than conveying the fresh water through Delta channels. Essentially, the project is an updated version of the peripheral canal defeated by California voters in 1982.

This report is the first comprehensive economic benefit-cost analysis of the proposed tunnel. We find the costs of the tunnel are 2.5 times larger than its benefits, and thus the project is not economically justified due to a benefit-cost ratio of 0.4.

Table 1: Summary of benefits and costs of Delta water conveyance tunnel in a typical year after it is complete, approximately 2030. (estimates in current dollars)

Benefits	**Annual benefits ($ millions)**
Export Water Supply at 5.5maf of exports	250
Earthquake Risk Reduction	50
Export Water Quality	200
Environmental Benefits at 5.5maf of exports	0
Total Annual Benefits	**500**
Costs	**Annual costs ($ millions)**
Debt Service Capital Cost	1,100
Operation and Maintenance	85
In-Delta and Upstream Impacts	65
Total Annual Costs	**1,250**

The BDCP is considering a variety of sizes and operating criteria for the water conveyance tunnel. This analysis focuses on a scenario that is reported in the press to be the preferred alternative emerging in BDCP negotiations. Reports suggest tunnels will be built that can accommodate conveyance of 15,000 cfs (cubic feet per second) with average annual water exports averaging between 4.5 maf (million acre feet) and 5.5 maf.[1] This assessment examines the most favorable operating criteria for financing the tunnels, the maximum average water exports of 5.5 maf. This analysis looks only at the water conveyance proposal in the BDCP, and does not evaluate habitat creation proposals that provide their own benefits and have

[1] "California Peripheral Canal Coming Soon." San Francisco Chronicle, June 3, 2012. Although there is no formal proposal, we have heard of a plan to build 3 intakes with 3,000 cfs capacity instead of 5 intakes, but to build the tunnels at 15,000 cfs capacity so that they could accommodate 2 additional intakes and increased pumping capacity in the future. This change would result in somewhat lower capital and operating costs, but is highly unlikely to result in a positive benefit-cost ratio.

several billion dollars in additional construction costs. As noted in a later section, this separate analysis is consistent with Department of Water Resources' economic analysis guidelines.

This preliminary benefit-cost assessment can be updated with new information as it becomes available. Our intention is to motivate public agencies and others to conduct comprehensive benefit-cost analysis, and to provide appropriate economic justification of the project. Given the poor performance of the tunnel in this initial benefit-cost analysis with several assumptions favorable to tunnel construction, it is highly unlikely that any subsequent benefit-cost analysis will find that the project is not economically justified.

Benefit-Cost Analysis

Benefit-cost analysis of large infrastructure projects is common practice, and broadly considered to be an essential part of good public policy analysis of large capital projects. For example, high-speed rail, the other California mega-project in the news, has included multiple benefit-cost assessments as the plan has evolved. The most recent accompanied the revised business plan and found most scenarios had about $2 in expected benefits for every $1 in expected costs.[2] The benefit-cost ratio of high-speed rail is five times higher than the benefit-cost ratio we have calculated for the Delta water conveyance tunnel.

Benefit-cost analysis of the tunnel conveyance has been called for in numerous reports and reviews of the BDCP, but still has not been appropriately conducted by any state agencies or published in any independent academic studies before this report. The Department of Water Resources (DWR) has an Economic Analysis Guidebook that provides a comprehensive description of DWR's approach to benefit-cost analysis.[3]

The DWR Economic Analysis Guidebook states the importance of benefit-cost analysis well,

> Economic analysis is a critical element of the water resources planning processes because it not only evaluates the economic justification of alternative plans but it can assist in plan formulation. (p. 1)
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> The economic analysis should answer questions such as, Should the project be built at all? Should it be built now?, Should it be built to a different configuration or size? Will the project have a net positive social value for Californians irrespective of to whom the costs and benefits accrue? (p. 5)
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> Benefit-cost analysis is the procedure where the different benefits and costs of proposed projects are identified and measured (usually in monetary terms) and

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[2]The April 2012 high-speed rail benefit-cost analysis can be downloaded from http://www.cahighspeedrail.ca.gov/assets/0/152/431/6515fa4a-a098-4b88-9f19-19f0e1475e19.pdf. The business plan and benefit-cost analysis of high-speed rail have been criticized for optimistic ridership projections, but this debate has strengthened the policy and planning process for the high-speed rail project. Many of the economic benefits of high-speed rail are health related such as reduced traffic fatalities and air pollution from reduced highway travel and the benefit-cost analysis attached monetary values to health and environmental benefits.

[3] The DWR Economic Analysis Guidebook is on the web at http://www.water.ca.gov/pubs/planning/economic_analysis_guidebook/econguidebook.pdf

then compared with each other to determine if the benefits of the project exceed its costs. Benefit-cost analysis is the primary method used to determine if a project is economically justified. A project is justified when:

- estimated total benefits exceed total estimated economic costs;
- each separable purpose (for example, water supply, hydropower, flood damage reduction, ecosystem restoration, etc.) provides benefits at least equal to its costs;[4]
- the scale of development provides maximum net benefits; and
- there are no more-economical means of accomplishing the same purpose. (p. 13)

The Department of Water Resources has recently contracted with the Brattle Group to conduct an Economic Benefit Analysis led by Dr. David Sunding of UC-Berkeley.[5] The "Benefits Analysis" rather obviously ignores the cost side of the benefit-cost equation, including negative impacts on third parties such as in-Delta and upstream interests. Dr. Sunding's analysis has not yet been released, but could and should be expanded to a comprehensive benefit-cost analysis. The benefits analysis in this report follows the framework in the Scope of Work for the BDCP Economic Benefits Analysis, and the numbers could be easily updated once the Brattle report is complete and available.

In the meantime, the objective of this report is to fill an important information void, and to challenge tunnel proponents to make their economic case using an accepted and established benefit-cost framework. Most of the values for benefits and costs in this report are taken directly or clearly derived from BDCP documents or reports sponsored or cited by tunnel proponents. Most assumptions required to derive values are made in ways that favor building the tunnel. The detailed sources and discussion of study assumptions are in the sections that follow.

On a technical note, it should be noted that the standard benefit-cost calculation is slightly different than the average year benefits and costs illustrated in Table 1. The average annual framework is conceptually easier to understand and often used for non-technical audiences. However, benefit-cost analysis looks at a full stream of benefits and costs over time, and uses a discount rate (equivalent to an interest rate) to calculate a present value of the path of future benefits and costs. Depending on construction time lags, financing terms, and other factors, the net present value approach can sometimes yield different results. Thus, we also enumerated the benefits and costs out to 2100 and calculated present values for each stream following the DWR guidelines. With this approach, the present value of benefits was $4.1 billion and the present value of costs was $9.7 billion. The benefit-cost ratio of 0.42 was only marginally improved over the 0.4 benefit-cost ratio using the easier to understand annual method summarized in Table 1.

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[4] This bullet point is critically important to the BDCP which some argue can only be evaluated as a package of water conveyance and habitat improvement projects. The DWR economic analysis guidebook is correct in stating that water supply and habitat projects should be evaluated separately.

[5] The Economic Benefit Scope of Work is available at http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Economics_Benefit_Scope_of_Work.sflb.ashx

Benefits of a Delta Water Supply Tunnel

Export Water Supply:

The best comparable estimate for increased water supplies arising from a Delta tunnel is a Berkeley Economic Consulting (Sunding et. al. 2008) report, "Economic Impacts of Wanger Interim Order for Delta Smelt"[6] that was prepared for water contractors affected by water supply reductions. Sunding et. al. estimated that the interim Delta Smelt restrictions reduced water exports in an average year by 586,000 af (acre feet), an amount that is close to the 800,000 af in exports that might be restored in the best water supply scenario for a Delta Tunnel. Sunding et. al. estimated the average 586 taf reduction in exports generated total long-run economic losses of $140 million ($92m urban, $48m ag) or about $239 per acre foot. Scaling the Berkeley estimate up to 800 taf (thousand acre feet) of water exports and current dollars results in an estimate that a tunnel could restore up to $200 million per year in water supply benefits.

Although socio-economic impacts are typically excluded from benefit-cost analysis ratios, it is important to note the special role of agriculture in the economic base of the impoverished San Joaquin Valley. Agriculture makes up about a 1/3 of the $200 million loss estimated above, and using typical income multipliers, an additional $50 million in indirect value added benefits could result from the increase in agricultural output and the resulting revenue is spent and circulates through the regional economy. Although these regional values are typically excluded from formal benefit-cost analysis, we have included them to increase the estimated total value of water supplies to $250 million annually so as not to underestimate the full socio-economic benefits of water to the Central Valley.

Earthquake Risk Reduction:

A massive earthquake that floods Delta islands and disrupts water conveyance is frequently used as justification for an isolated water conveyance facility around the Delta. However, if a massive earthquake were to cause ten or more Delta islands to simultaneously flood, the human and economic losses that would result are much larger than the impact on water supplies. According to the Delta Risk Management Strategy (DRMS) reports, hundreds of people in the Delta would drown in such a catastrophic flood, possibly more. In addition, the DRMS reports found that interruptions of export water supply would be only 20% of the economic loss of such a catastrophe. Much larger economic losses would come from disruptions to natural gas systems, electricity transmission and generation, state highways, ports, railroads, and significant losses of in-Delta businesses, homes, and farmland. If it makes sense to spend billions of dollars on a Delta tunnel to protect water exports from earthquake, it must certainly make sense to spend a similar amount on seismic upgrades to Delta levees which protect both water exports and a multitude of other economic risks that are collectively four times more valuable than water export interruption. Unlike a tunnel, seismic levee

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[6] The report is available at http://www.berkeleyeconomics.com/BEC.FinalReport.8Dec08.pdf

upgrades could also save hundreds of lives and prevent environmental destruction of such a catastrophic flood.

Two reports by state agencies have identified seismic levee upgrades as a viable earthquake risk reduction strategy in the Delta.[7] The Delta Protection Commission Economic Sustainability Plan estimated the cost of seismic levee upgrades at between $2 billion and $4 billion, including riparian habitat enhancements on the enlarged levees. A 2007 PPIC report estimated the cost of a similar Dutch style, "Fortress Delta" strategy at $4 billion.[8] This strategy is 1/6 to 1/3 the cost of the proposed water conveyance tunnel, and provides a much larger and broader range of risk reduction benefits to the economy.

Understanding the larger picture of earthquake risk is essential because benefit-cost analysis is based on "with and without" comparisons to the next best alternative. It is hard to envision that the state and federal governments would allow the seismic risk to human life and other economic assets in the Delta to remain unaddressed even if water exporters moved ahead with a Delta tunnel. Since necessary seismic upgrades to Delta levees could be completed by the time a Delta tunnel conveyance was constructed, a water supply tunnel would create no additional seismic protection for water exports. In this scenario, the earthquake risk reduction benefits of the water supply tunnel are zero.[9]

If alternative strategies are ignored, an upper bound to earthquake risk reduction benefits could be calculated by assuming the extreme DRMS scenario occurs without any actions to reduce risk. Dr. Robert Gilbert of the University of Texas, a reviewer of DRMS and the Economic Sustainability Plan, recently testified to the Delta Stewardship Council that under DRMS the expected present value of earthquake losses to water exports is $2 billion over 100 years. The annualized expected value of these water supply losses is roughly $100 million per year. The DRMS scenario is an extreme case with high levee failure probabilities and an extreme assumption that no action is taken to reduce a known catastrophic risk. Thus, $100 million per year is a high estimate of expected annual earthquake related losses that could be avoided with a Delta water conveyance tunnel.

Although we include $100 million as an upper bound, we believe zero is a more appropriate value for benefit-cost analysis, since seismic upgrades to levees have already been identified in two state agency reports as a superior seismic risk reduction strategy than a canal or tunnel. To

[7] "Economic Sustainability Plan for the Sacramento-San Joaquin River Delta." Delta Protection Commission. January 2012. http://www.forecast.pacific.edu/desp.html. "Risks and Options to Reduce Risks to Fishery and Water Supply Uses of the Sacramento/San Joaquin Delta." Department of Water Resources and Department of Fish and Game. January 2008. http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/AB1200_Report_to_Legislature.pdf.

[8] The PPIC ruled out a "fortress Delta" solution in 2007, because its $4 billion cost was seen as too high, and they assumed a peripheral canal cost only $3 billion. The PPIC also ignored or downplayed public safety and the risk to non-water supply infrastructure. See "Envisioning Futures for the Sacramento-San Joaquin Delta" Public Policy Institute of California, February 2007. http://www.ppic.org/main/publication.asp?i=671

[9] If the tunnel conveyance were implemented as part of a Delta policy package that prevented or delayed seismic levee upgrades in the Delta, one could argue that the earthquake risk reduction benefits to the state of a tunnel are negative compared to the best alternative.

be conservative, our summary uses a value of $50 million, the center of the range from $0 to $100 million.

Export Water Quality Benefits:

Improved export water quality is a significant benefit of the proposed Delta tunnel.

The potential water quality benefits of new Delta conveyance to exporters have been the subject of several assessments. The Southern California Water Committee has recently used a 1999 Salinity Management Study by Metropolitan Water District and the U.S. Department of Interior as a source for water quality benefit estimates. This report estimates $41 million in total water quality benefits in 2000 from a Cal-Fed dual conveyance proposal that is similar to the current tunnel proposal.[10] This is roughly $60 million in current dollars, comparable to a $30 - $90 million range of urban water treatment benefits the PPIC (2008) estimated would result from an isolated conveyance strategy that would take all export water from the north Delta. The 2008 PPIC report also estimates $140 million in benefits to agricultural water exporters from moving intakes from the South Delta to the Sacramento River near Hood. Taken together, the estimates of water quality benefits to urban and agricultural water exporters is roughly $200 million per year. Updated assessments are underway as part of the BDCP process, but $200 million is a reasonable approximation of water quality benefits for the purpose of this report. Water quality to Delta water exporters may be the most valuable of all the economic benefits.

It is important to note that the tunnel itself does not do anything to purify water supplies. It improves export water quality, because the tunnel moves Delta water exporters' diversion points to a stretch of the Sacramento River between Clarksburg and Courtland where water quality is better. The new intake would be upstream of the existing diversions of Sacramento River water by Delta farmers, the Contra Costa Water District, and the cities of Stockton and Antioch, whereas the current intakes are downstream of these users. Thus, any water quality benefits received to the export projects will be at least partially offset by a degradation of water quality to those water users who will now be downstream of the massive intakes of the new tunnel. Many of these offsetting costs have not been thoroughly analyzed, but are at the root of much of the in-Delta opposition to the proposed Delta tunnel. Some of these potential costs are included in the In-Delta and Upstream Impacts section in the cost assessment that follows.

Environmental Benefits:

At equal levels of water exports, a water supply tunnel could have environmental benefits for endangered fish over the current diversion location in the south Delta that causes reverse flows in some Delta rivers and entrainment of endangered fish in the pumps. However, as water exports are increased beyond the no-tunnel estimate of 4.7 maf of average exports, the marginal environmental benefits of a tunnel diminish. The BDCP's most recent "effects analysis" found that an operating plan that includes 5.9 maf of average exports would harm many of the endangered species the BDCP intends to help. This benefit-cost analysis assumes

[10] See table 3-6 of the Salinity Management Study. http://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/drinking_water_npdes_renew/attachments/att_22_mwd_usbr_salinity_mgmt_study_1999.pdf

an increase in water exports to a slightly lower level of 5.5 maf, the maximum of the 4.5maf to 5.5maf that is reported to be under current consideration. At the maximum level of water exports, most if not all environmental benefits that could directly result from a tunnel are consumed or monetized in the form of higher water exports.[11] If the tunnel were operated at lower levels of water exports, there would be an increase in environmental benefits, but the water supply benefits would drop substantially from our estimate of $250 million per year. This trade-off between export water supplies and environmental benefits has been at the center of much of Delta discussions. Because increased water exports are the key to financing the tunnel by water contractors, we believe that a more environmentally beneficial scenario of tunnel conveyance that does not result in increases export water supplies is financially infeasible and irrelevant. Thus, we focus on the most realistic case of maximum possible water exports.

Costs of a Delta Water Supply Tunnel

Capital Costs:

We use construction costs from Chapter 8 of the February 29, 2012 Draft Bay Delta Conservation Plan (BDCP).[12] The cost estimate of $12.7 billion is identical to the cost estimate in an earlier November 2010 draft of the BDCP. There are news reports that tunnel cost estimates have risen to $14 billion[13] and possibly more, but there are no official updated estimates available, so we are utilizing the lower estimate. Chapter 8 of the BDCP describes a financing strategy for construction that would involve issuing a series of 4 revenue bonds with 40 year repayment terms. Debt servicing costs are estimated at $1.1 billion annually from 2021 through 2056, and the last of the bonds would be retired in 2061.

Operating and Maintenance Costs:

The February 29, 2012 draft BDCP estimates operation and maintenance costs for the Delta tunnel at $85 million annually.

In-Delta and Upstream Costs:

The water supply tunnel will generate a variety of costs on in-Delta and upstream uses. As discussed before, the large new diversion on the Sacramento River will degrade water quality for those who divert Sacramento River downstream from the proposed intakes. These users include Delta farmers, the Contra Costa Water District, the Cities of Antioch and Stockton, industrial user such as power plants in eastern Contra Costa County, and the North Bay Aquaduct that serves Napa and Solano. In addition, the footprint of the tunnel facility will eliminate Delta farmland and property (although less than a surface canal), and five massive

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[11] The effects analysis of the February 2012 BDCP draft found that a tunnel with somewhat higher average exports of 5.9 maf harmed the endangered fish species the BDCP is intended to conserve. Some argue that average exports of 5.5 maf will still result in environmental costs.

[12] http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/BDCP_Chapter_8_-_Implementation_Costs_and_Funding_Sources_2-29-12.sflb.ashx

[13] Weiser, M. *Sacramento Bee,* February 20, 2012. "Water Tunnels Would Be Huge Project—If They Clear Huge Obstacles."

new water intakes will create substantial visual and noise pollution along a scenic, rural stretch of the Sacramento River, harming Delta residents and detracting from recreation and tourism in the area. Upstream users, such as the North State Water Alliance, are concerned that the tunnel operation could reduce upstream water supplies, and result in lower reservoir levels which could affect hydroelectric power generation and recreational use of reservoirs.

Economic values have not been estimated for most of these impacts. The Delta Protection Commission Economic Sustainability Plan estimated a water conveyance tunnel would result in an average of $65 million in annual losses for Delta agriculture; including about $50 million in losses from reduced water quality, and an additional $15 million in annual crop losses from roughly 8,000 acres of farmland lost to construction impacts and the physical footprint of the facilities.[14] It is possible that a tunnel operated for environmental benefits would be more protective of in-Delta water quality and result in lower impacts on Delta agriculture. Even if Delta agriculture impacts were lower than $65 million, the other impacts to in-Delta urban water intakes, Delta communities, and upstream water users would surely push the overall cost of in-Delta and upstream impacts higher. We use $65 million as a very conservative, preliminary estimate of the costs to in-Delta and upstream interests.

Financial Feasibility and Ratepayer Impacts

Benefit-cost analysis is sometimes confused with financial analysis and ratepayer impacts. Benefit-cost analysis does not estimate rate increases as these depend upon a number of financing assumptions, the amount of public investment, and cost recovery principles. Benefit-cost analysis is a tool for policy analysis and decision making that informs whether a project should be built.

In contrast, financial feasibility analysis simply investigates whether a project can be financed and paid for, whether or not it is economically desirable or the most cost-effective way to meet a given objective. Financial feasibility must be demonstrated for certain regulatory requirements, and also must be proven to investors who are needed to buy bonds to finance construction. Financial feasibility is clearly linked to estimating ratepayer impacts since increased water rate revenue will be required to finance the bonds.

Although the BDCP has yet to develop a detailed financial plan, water contractors have said that the cost of the tunnel would be paid in proportion to the water received through the tunnel. For example, Metropolitan Water District, has said it expects its ratepayers to pay for 25% of the cost of the tunnel, equivalent to their share of Delta water exports. However, the high cost of the Delta project raises serious affordability questions for the agricultural users who receive the majority of water exported from the Delta. The cost of irrigating with water exported through the tunnels would exceed the profits of many crops grown in the Central Valley.

The most recent draft of the BDCP and a new report by the Southern California Water Committee suggests a different financing approach. These new reports compare the cost of the

[14] http://www.forecast.pacific.edu/desp.html

tunnel to urban rather than agricultural water supply projects. The draft BDCP financial analysis states the project is feasible because its per capita cost is smaller than some urban water projects financed by local urban water agencies.

The per capita financial feasibility analysis in the draft BDCP is inconsistent with the statements water contractors have made about financing for the past five years. The Delta water conveyance tunnel is primarily an agricultural water supply project; farms use double the amount of water conveyed through the Delta than cities. If costs are allocated on a per capita basis, Metropolitan Water District ratepayers would be responsible for 75% of the project costs (they are 18 million of 25 million people who receive some Delta water), not the 25% that is proportional to the water they receive. The use of financial feasibility analysis that allocates the full cost of the project on a per capita basis implies that urban ratepayers will be asked to pay large subsidies for agricultural water supplies in their bills. However, such a non-proportional financing scheme would seem at odds with California Proposition 218.

The bottom line is that water agencies that are responsible for financing the Delta tunnel have yet to prove that it is financially feasible. The BDCP financing chapter makes inconsistent statements about whether the project costs will be allocated on a per capita basis or proportional to water received.

Conclusion

This report is the first comprehensive benefit-cost analysis of the Delta water conveyance tunnel proposed as the centerpiece of the BDCP. We find a benefit-cost ratio of 0.4, meaning that there is $2.50 of costs for every $1 in economic benefits. When these very low benefit-cost ratios are considered alongside the inconsistent and incomplete financial plans, it is clear that the Delta water conveyance tunnel proposed in the draft BDCP is not justified on an economic or financial basis.